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Strategic vision 2008-2012

CIRAD

Strategic vision 2008-2012

Key topics
Revised practices

CIRAD

Foreword

Food insecurity, which is one of the many facets of poverty, returned to the spotlight on the global stage in the early years of the millennium. Unfortunately, this merely served to remind those working to improve living conditions for poor populations in the least advanced countries of the task facing them. CIRAD is among them, and more than ever, it intends to fulfil its mandate of targeted research for development by devoting its expertise to the following objective: inventing a form of agriculture capable of feeding eight billion people by 2030, an equitable form of agriculture, that preserves the health of all the world's citizens as well as the environment around them.

CIRAD's strategic vision, as ratified by the Board of Trustees in December 2007, spells out that commitment. It is a positive signal that we intend to transmit to the global scientific agricultural research community.

The aim is to voice our expectations and confirm our identity. We outline the topics that will be focused on and how our practices should be revised. Finally, the document underlines CIRAD's readiness to develop forms of dialogue and cooperation with countries in the Souths, while respecting the highly diversified range of partners' identities and constraints.

In-house discussions, partners' opinions and contributions of consultancy bodies were the starting point for the strategy renewal proposals. Four key points illustrate CIRAD's new stance: development issues should be managed on a per-locality basis rather than simply applying generic development models; participation of all development stakeholders is essential, especially training specialists; scientific publications are vital, but the main "outputs" of this targeted research should be serviceable in the partner countries; and finally it is crucial to focus specifically on the scientific elements underlying public policies and governance, which are important emerging issues.

CIRAD has reached a major milestone. The present document fulfils the need for clearcut guidelines to facilitate management decision making, while specifying our contribution to public policies, especially those concerning research and cooperation. Note that this strategic planning initiative is a follow-up to the decision to reconsider CIRAD's scientific governance strategy and represents a real effort towards consolidation.

Patrice Debré
Chair, CIRAD Board of Trustees

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Introduction

The world around us is constantly changing, largely as a result of economic globalization and new modes of communication. Increasing food and energy requirements have placed agriculture firmly in the spotlight on the world stage. The future of agricultural operations and of the people involved is a major global issue. Moreover, the research sector, notably in France, is undergoing massive changes and is becoming more uniform, under the influence of standard evaluation criteria.

Against this backdrop, CIRAD General Management has decided to renew the establishment's strategy and revise its research practices. A debate was launched in 2006, and involved many CIRAD staff members in 2007, supported by the Science Council. It resulted in the drafting of three strategy documents, which were approved by the Board of Trustees on 18 December 2007, and will also be used to draft the 2008-2011 Contractual Agreement between CIRAD and the French State, to be signed in the spring.

These documents will serve to fuel discussions with current and potential partners. The resulting meetings and talks will enable us to adjust our research topics, objectives and structures, and provide us with information on possible partners and modes of cooperation. They will help us determine what we want to do, with whom and for whom.

The aim is to make the collective work done by the establishment's staff more coherent, so as to make the authorities and the general public aware of the unusual position CIRAD has occupied for almost twenty-five years now, and the role it intends to play in terms of agricultural research for development.

More than ever, much is expected of us, in relation to very delicate issues, and we have the capacity to come up with relevant, original solutions, including appraisal and training services. This document sets out the backbones of the strategic lines on which CIRAD will be basing its scientific and communication operations. Their implementation will gradually be reflected in the scientific projects conducted by its research units.

Gérard Matheron
CIRAD Director General

Pinpointing development issues

The dissemination of scientific and technical progress, public development aid, trade liberalization and economic globalization have not given all the desired results.

The effects of these factors on development in the South are not always positive, and even if economic growth is strong, it does not always bring the social progress that might be expected. The technologies generated by the "green revolution" have clearly helped to reduce the number of major famines, but more than 800 million people worldwide[1] *still suffer from food insecurity and do not have access to even the most fundamental of human rights: health, physical safety, food safety and security, education, and a healthy environment*

[1] FAO, *"Undernourished population"*, 1970-2003 (http://www.fao.org/es/ess/faostat/foodsecurity/FSMap/flash_map.htm).

The fruits of development are unevenly distributed

Economic inequalities and social divides are growing, both between developing countries, and within countries. The term "the South" now covers a range of situations: on the one hand, emerging countries with such strong economic growth that they are commonly called "giants" or "dragons", and on the other, emerging crisis situations in which the very notion of Statehood is losing its meaning. This is why it is now more appropriate to talk of the "Souths"[2]. Countries, regions and players are changing in varied ways, a world away from the concept of "universal" development based on the western world model. The range of responses among the social systems of the "Souths" to a form of globalization imposed by industrialized countries is proof, if proof were needed, that there is no such thing as standard globalization with benefits for all. Countries have taken various aspects of globalization on board, with variable benefits. China, Brazil and India are emerging as future global economic hubs, while much of sub-Saharan Africa seems to have been left by the wayside.

The "development" concept has become highly complex. For instance, the poorest countries' legitimate wish to consume has run up against the impossibility of allowing all of the world's inhabitants to draw on natural resources to the extent that those in the richest countries have done. As a result, the interdependence between North and South needs to be restructured. While economic viability is both a prerequisite and a driving force, it is not sufficient to ensure development. "Sustainable human development" encompasses social and environmental aspects through two complementary principles: solidarity within a given generation, and solidarity between the current generation and those to come. There is no single path to development, but a multitude of paths tailored to each society and established through innovation processes either generated or taken on board by the beneficiaries themselves. For the sake of both the planet and of economic growth, we must take a systemic approach if we are to understand and support sustainable relations between human societies and nature in its broadest sense.

These changes in the development concept require an in-depth rethinking of the types of questions asked of research, but also of research practices themselves.

[2] Call for projects, Agence nationale de la recherche, ANR 2007, *"Les Suds, aujourd'hui"* (http://www.agence-nationale-recherche.fr/AAPProjetsOuverts?NodId=17&IngAAPId=128), led by the Agence inter-établissements de recherche pour le développement (AIRD, http://www.aird.fr/).

"Development can be seen as a process of expanding the real freedoms that people enjoy. Focusing on human freedoms [or capabilities] contrasts with the narrower views of development, such as identifying development with the growth of gross national product, or with the rise in personal incomes, or with industrialization, or with technological advance, or with social modernization."

Amartya Sen, Indian economist, Nobel Prize for Economics in 1998.

Renewed awareness of the role of agriculture in development

In most developing countries, a large proportion of the population is, and will continue to be, dependent on rural and agricultural activities. Family agriculture employs almost 1.5 billion people worldwide, and in the least advanced countries, two thirds of jobs are directly linked to agriculture[3]. Even with increasing urbanization and industrialization, these rural populations make up the majority of the world's poorest people.

Hence the importance of agricultural development and the positive role it can play in alleviating poverty, ensuring political stability and avoiding conflict. Agriculture is a key factor in social change. The World Bank pinpoints agriculture as the most credible way of ensuring the right to development and significantly alleviating poverty[3]. Former UN Secretary General Kofi Annan is calling for a new green revolution in Africa, which he sees as the only way to eradicate poverty and hunger in the long term[4].

Agricultural activities lie at the heart of the challenge of feeding some eight billion humans and supplying them with energy by 2030, while preserving the environment and natural resources. For the poorest populations, both rural and urban, agriculture is still the main means of accessing essential goods and services: it ensures not only food supplies, but jobs, income, the possibility of accumulating capital (for instance through animal production), sustainable land use, the possibility of industrialization, etc. As a global public good, agriculture is set to play a growing role in preserving and improving energy supplies, the world's climate, plant and animal biodiversity, and human and animal health.

Factors linked to agricultural production are thus essential to the cohesion and evolution of human societies. The changes now under way —whether through trade globalization, the decline of certain States, population pressure, desertification, international migration, urbanization, ecological imbalances or the energy crisis— have a profound effect on agricultural production, rural areas and consumption patterns. The future of agricultural activity and of the people who depend on it is a major issue for the future of the planet.

[3] World Bank, 2007. *"World Development Report 2008: Agriculture for Development"*. Abridged. World Bank, Washington DC, 36 pp.

[4] Kofi Annan, *"Pour une révolution verte en Afrique"* Le Monde, 11 July 2007.

The main issues facing the «Souths» contain three

The human and social issue

"Setting the poverty line at 2 dollars a day has excluded almost half the world's population from the circuits of wealth"[5].

Poverty is a multidimensional phenomenon of inequalities and exclusion. Its origins and dynamics lie in the balances of power that structure societies. On an international scale, poverty is one of the priorities for public development aid.

Nutrition and food security and safety have become major development issues, and concern both rural and urban areas. For a long time, the concept of food security referred almost exclusively to the amount of food available. The main research aim was to increase productivity and calorie availability.

Now that access to food is seen as a fundamental human right, it is generally accepted that except in crisis situations, malnutrition is due less to a lack of food and more to people's lack of resources for obtaining that food. It is also vital to take account of the variety and balance of types of food, food quality and consumer preferences.

The steady spread of emerging or reemerging animal diseases is posing a major threat to animal and, increasingly, to human health.

Animal diseases that can be passed to man are a serious risk for populations in the South and some populations in the North. Protecting human health also means taking account of the economic concerns of rural populations for whom animal production is one way of satisfying growing demand from consumers and is often their main form of capital, making it a tool in alleviating poverty.

[5] French Ministry of Foreign Affairs, 2001. *"Lutte contre la pauvreté, les inégalités et l'exclusion"*. MAE, Paris, "Repères", 32 pp.

The need for agricultural research in partnership with the “Souths”

Research in its broadest sense is one of the best ways to help solve key problems. Issues relating to development are of a global nature: questions raised in the South may apply to the North, answers to problems in the North may be found in the South. This is why people worldwide have high expectations of research. Addressing these global questions means changing the content of research programmes, freeing up resources equal to the issues, strengthening the links between research organizations in the North and the South, and improving uptake of research results.

Research itself has not escaped globalization. Information and communication technologies mean that research teams worldwide are now in competition, but also have new opportunities to work together. National and international agricultural research landscapes are changing rapidly. In France and in Europe, national organizations and universities are keen to work more on an international level, for instance in the fields of the environment and risks. On a global scale, private firms play a determining role, particularly in the areas of agrifood technologies and genetic resources. The scientific capacity of emerging countries is fast approaching that of the most developed countries. Conversely, the withdrawal of certain States has weakened many national research systems, and regional restructuring efforts have not always managed to compensate for this.

In this climate of inequalities and change, CIRAD affirms the need for public agricultural research in partnership, both in the South and with the South. This research focuses on the Millennium Development Goals (UN)[6] and also on the issues that developing countries raise for France, Europe and the world, particularly as regards the environment and preventing conflict. On both a local and a global scale, the public research sector needs to work on those questions likely to trigger innovation processes in societies in the “Souths” or linked to the production or preservation of public goods.

[6] United Nations Organization: Millennium Development Goals (http://www.un.org/millenniumgoals/).

Reaffirming
CIRAD's identity and revising its practices

CIRAD has a long history of links with hot regions, and unique experience in environmental studies, agronomy, agricultural and livestock product processing, animal health, and forest management. Multidisciplinarity and strong institutional and cultural ties are CIRAD'S indisputable assets. The combination of rich experience and key disciplines helps CIRAD define the social, environmental and economic criteria for its strategy, its programmes and the applications of its research. These criteria —quality, relevance and impact— also mean finding new ways of conducting targeted research.

CIRAD is determined to produce high quality scientific outputs

CIRAD is aiming for a recognized role among national, European and international research organizations. The assets it draws on stem from scientific research: its scientific legitimacy relies on the constant demonstration of its results and expertise, and the recognition of its peers. CIRAD must produce quality scientific publications in a climate of competition in which national and international evaluation systems generally focus on publications. However, CIRAD's scientific legitimacy must also be linked to the implementation of concrete operations for development. The volume and quality of its scientific publications cannot, therefore, be the only criteria in choosing its operations. CIRAD needs to take care to improve the quality of its outputs as a whole, not just of its scientific publications.

Targeted research for development in the South is what makes CIRAD stand out from the crowd. Rather than being just a combination of fundamental research and an applied objective, targeted research is a process for building research questions based on the socioeconomic needs of players. CIRAD generally builds its research operations jointly with it partners. This ensures relevant research programmes and determines CIRAD's identity and its future.

This means keeping a constant watch on strategy so as to remain in touch with global changes, to feed debate, assist the decision-making process and support any necessary adjustments to research programmes. Permanent working groups must therefore continue the current work and debate prospective studies and strategy. Active researchers are an essential part of these working groups since their fieldwork sheds light on the social realities of development.

> **"Targeted research processes thus include a wide range of operations: from monitoring society, building and maintaining relations with partners, identifying problems encountered by players, acquiring knowledge, generating relevant knowledge, putting generic knowledge in context, adapting that knowledge to the language used by players and converting it into tools for subsequent action. It thus includes a degree of fundamental research: solving the problems raised by socioeconomic players and producing operational knowledge often means making a detour via more fundamental research on topics that are chosen because they will serve to overcome cognitive, methodological or technological obstacles. Moreover, seeking solutions in a specific situation will not succeed unless we increase the genericness of the results, leading researchers to help generate knowledge that will also be of use in other situations."**
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> Report by the group of organizations covered by the French organic law on finance laws LOLF 187, on 2007 evaluations (internal document).

CIRAD is committed to planning the agricultural research of the future to benefit the world's poorest populations

As the World Bank's World Development Report 2008 points out, agriculture remains fundamental for achieving sustainable development and alleviating poverty. Three-quarters of poor people in developing countries live in rural areas; 2.1 billion people live on less than two dollars and 880 million on less than one dollar a day. Most make their living from agriculture[7].

These poor inhabitants of rural areas are the main victims of global imbalances and diminished global public goods. It is these men and women who should be benefiting from CIRAD's work[8], and it is to them that CIRAD is most committed: CIRAD must use its expertise and know-how to help pinpoint the questions underlying "sustainable human development" and find relevant social, economic and ecological solutions.

CIRAD needs to forge alliances and create networks for continued contextualized research to benefit developing countries. This means constant reference to a "research for development" ethic. Operations and research programmes are thus chosen based on criteria centred on three main topics—poverty alleviation, global public goods, and State rebuilding—that are the basis of virtually every public development aid policy, whether in France, Europe or most funding agencies.

Historically, the institutes that originally made up CIRAD switched from directly carrying out research operations in developing countries to cooperation based upon researchers being assigned in-country, initially for a transitional period to allow for local scientific capacity-building. This partnership system has evolved today towards mutual collaboration with scientific institutions on common objectives[9]. In addition, the diversity of issues and fields involved has greatly multiplied the number of CIRAD's partners. These now include universities, farmers' and producers' organizations, nongovernmental organizations, businesses, etc. The levels of organization of these groups range from national or regional to a global scale, and the quality of their work varies significantly. Certain national research organizations require support, since they do not yet have the potential to meet their priority objectives, while others have achieved a level of quality that meets international standards. In response to this range of types of knowledge and global visions among CIRAD's partners, building research programmes jointly and sharing the fruits of our labours (publications, innovations, patents and any products obtained) has to be the rule rather than the exception.

[7] World Bank, 2008. *"World Development Report 2008: Agriculture for Development"* Abridged. World Bank, Washington, 36 pp.

[8] CIRAD Ethics Committee, 2004. View of the CIRAD Ethics Committee on how to intervene among rural communities in developing countries: «Must we, can we and if so, how can we involve rural communities, particularly the very poorest, in drawing up and conducting the research operations that concern them?». 8 March 2004, published on 3 September 2004, 4 pp., (http://www.cirad.fr/en/actualite/communique.php?annee=2004&id=146).

[9] CIRAD 2004. CIRAD's evolution as viewed by its partners; p. 44-48.

The main three issues facing the «Souths»

The environment and energy issue

The environmental threats to the planet (shrinking biodiversity, climate change, emerging diseases, phytosanitary risks, etc) are well known, and farming practices are partly responsible.

The futures of countries in the North and of those in the "Souths" are inextricably linked. There is a pressing need to work together to tackle issues such as greenhouse gas emissions and to reduce weather hazards. Dialogue on environmental and energy issues is vital since the direct resources provided by the environment are often the main assets available to people in rural areas of poor countries.

While intensive agricultural production models have enabled spectacular increases in productivity, they have also demonstrated their adverse effects on natural ecosystems and human health, and their unsuitability for poor farmers due to their high energy costs and pollution effects. In both the North and the "Souths", farming systems need to be increasingly economical in terms of inputs and more benign in terms of their impact. This means a new type of agricultural research, based on understanding and using the ecological processes at play within agrosystems and also on analysing the socioeconomic processes that either favour or hinder the adoption of new practices[10]. This new type of agricultural research centres on the concept of ecological intensification.

Finally, under the dual threat of a shortage of fossil fuels and of radical climate change, it is essential that 21st-century human societies speed up technological and social change, so as to find new energy sources and cut energy consumption. Countries in the "Souths" have advantages in terms of climate and plant species that enable high biomass yields. This biomass could be converted into energy (electricity, biofuels, etc) or into high added-value products that could at least partly replace oil derivatives.

[10] Michel Griffon, Bernard Chevassus-au-Louis, In *"Rapport Demeter 2008: le défi de la modernité"* (publication pending). (URL http://www.clubdemeter.com/).

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Indicators of the success or failure of CIRAD's research projects thus need to take account of local views and knowledge. The legitimacy of CIRAD's research depends upon its connection to local priorities and the results its beneficiaries are entitled to expect. This is why social sciences need to play a greater role in the choice and implementation of research projects. Research for development serves to boost local scientific expertise and contributes to the emergence of centres of excellence, but it is often difficult to link the scientific results obtained to direct effects on development. It is not enough to provide the intended beneficiaries with products and services; these outputs need to have proven impact. Real impact is most likely to be achieved if preference is given to projects that favour innovation processes and use networks involving local players. CIRAD's experience of project design and its ability to bring skills together to implement complex, systemic approaches enable it to promote integrated approaches, from research to the emergence of innovation networks, which will themselves become the local relays for continued independent, local development.

In this context, training, which is one of CIRAD's mandates and a task required of its researchers, serves to supplement scientific aid by giving partners and development players the means to make the choices they must make independently. It is one way of reducing the imbalance of information between North and South. CIRAD's training efforts therefore are not a unilateral process of transferring knowledge from North to South but must take account of the social worlds of its partners.

"Our partners' expectations are changing profoundly, as is the nature of partnership links. There is a shift from a relationship of transfers to "clients" to one of collaboration between researchers. This calls for a restructuring of the ways in which CIRAD works with other organizations and a debate on the resources to be made available. The export by the North of ready-made research projects and traditional development aid needs to be replaced by demand for sustainable partnerships, for CIRAD to involve itself in organizing research networks between partners in developing countries, for joint building of research projects and for help for those partners with planning their own operations. CIRAD has to take its share of the responsibility for organizing this change by advocating it on a European and international level.".

Science Council statement dated 7-8 October 2004.

CIRAD needs to maintain close links with its partners in the South and encourage its partners in the North to follow suit

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Throughout its history, CIRAD has forged and maintained close links with communities in developing countries by working in the field, where they practise their agricultural, animal and forest production operations, and by experiencing their physical and biological environments. This has enabled CIRAD to establish itself in some 50 countries in Africa, Latin America, Asia and the Pacific. CIRAD works with national agricultural research organizations, and is increasingly collaborating with universities, regional centres, businesses, nongovernmental organizations, professional organizations and producers' associations. The strong and sustained international presence of CIRAD's researchers has shaped the establishment's identity. Researchers' immersion in local development realities is one of CIRAD's main assets, and a guarantor of the quality and sustainability of its partnerships. CIRAD's work alongside its partners means that it is familiar with the range of issues surrounding development: the technical, economic and social conditions for agricultural production, environmental dynamics and health risks. This knowledge, acquired in a range of situations, enables comparative analyses that provide a wealth of information. Knowledge based on local situations can often raise questions on issues of global interest and give rise to solutions that are applicable well beyond the local sphere.

In developing countries, through specific investments, CIRAD wants to continue to build research platforms and networks in partnership, which are attractive on a regional and international level. Within these platforms, scientific supervision and the scientific environment must be provided for long enough to maximize the opportunities for interaction between researchers and organizations, and to facilitate joint building of research topics and joint scientific outputs throughout the research cycle.

In the French overseas regions, CIRAD is also deeply committed to local as well as international issues, and it has helped to strengthen local scientific communities. These regions will remain a priority for CIRAD, although it is now necessary to look again at its operations. These must be geared towards new expectations on the part of local French partners, the expected end to European structural funding of the research sector, and the position of each of these regions within its larger geographical area.

Research organizations in the North increasingly have to cope with the globalization of certain issues, for instance that of emerging animal diseases. This may enable CIRAD to convince more researchers and organizations in the North to work on development issues, particularly through its networks of partners. This is a real opportunity for CIRAD and is a reason for playing an active role in federative research structures in France and Europe, and particularly in joint research units, alongside other research and higher education establishments. Similarly, CIRAD, along with its European partners, is striving to help build specialized, coordinated research and teaching structures in Europe and in developing countries.

CIRAD needs to spell out the criteria on which it bases its geographical partnership choices

It is no longer either effective or appropriate to choose research projects and partnerships based on the notion of "developing countries" or "countries in the South" alone. Countries and partners in the so-called "South" are increasingly heterogeneous, with a wide range of operations and very different expectations in terms of partnerships. For CIRAD, this applies to both agricultural development issues and local research ambitions and capacity. It is therefore now crucial to determine clear criteria, both for internal use and with respect to partners, so as to explain clearly how and why priority topics and specific modes of intervention (means used, funding, type of partner, etc) are chosen.

The aim is both to make CIRAD more efficient, by using means that are truly appropriate for local conditions, and to increase its legitimacy, by tackling issues that make sense both in France and in the countries in which CIRAD works.

These criteria refer to the three rationales on which the establishment's identity is founded: that of quality scientific output, that of development aid policies, and lastly, that of agrifood policies, in France and in Europe as a whole (in their broadest sense, encompassing agriculture, food, the environment and biodiversity).

The first criterion hinges on the quality of the scientific outputs that could be produced with potential partners, the quality of their teams and infrastructures, and their range of experimental fields. This criterion determines both the merits of each research partner and the conditions required in order to be able to work together, particularly in terms of skill-building.

The second criterion to be adopted at CIRAD refers to French, European and international public development aid policies, which now centre on three elements: alleviating poverty and inequality; managing global public goods; and rebuilding States. These three elements serve to identify groups of countries, depending on the objectives CIRAD is required to work towards: "emerging" countries, for managing global public goods (environment, biodiversity, health, security); "least advanced" countries, for alleviating poverty and inequality; countries in which the State is fragile, for rebuilding States.

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The third criterion considers the way in which CIRAD's operations in the various countries "in the South" interact with the agrifood policies adopted by French and European society. While it is not one of the main priorities, it is important when making choices to adopt a principle of coherence or shared interest, or at least of ensuring that operations do not clash violently with the interests of the agrifoods sector.

All partnerships have to satisfy, in an explicit, well-argued way, the principle of generating shared scientific knowledge. They need to differentiate, depending on the level of economic development in the partner country, between the desired objectives in terms of public development aid, without jeopardizing the interests of the French and European agrifoods sector.

The ever-changing scientific projects to be conducted by CIRAD's research units, and its regional structures, which take account of requests expressed by its partners, will take on board the results of applying this method. They will set out how rational choices of both operational fields and partners serve to fuel scientific changes at CIRAD in terms of its six strategic lines of research.

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The main three issues facing the «Souths»

The public policy and governance issue

Including the fight against inequality and exclusion in the fight against poverty poses the question of the effects of public policy on poverty.

This demands renewed attention to the role of the State and to its responsibility. Poverty is the result of various processes, some social, some economic, and research is needed to analyse and understand these processes.

Nowadays living conditions on family farms are directly affected by three types of factors: trade liberalization, direct competition between farming systems on every continent, and State withdrawal from support and supervisory services and infrastructure provision. In many regions of the South, mass exclusion of rural populations is under way, and economic change is preventing those populations from being absorbed into other sectors of activity.

Since the World Summit on Sustainable Development in Johannesburg in 2002, it has been widely agreed that it is essential both to introduce political regulatory mechanisms and to mobilize civil society if we are to reduce the structural inequalities that sustain "underdevelopment". This accepted hypothesis provides new food for thought on State action on a local, national and international level.

Extension of cropping, forestry and animal production generates strong pressure, and sometimes even conflict in societies. It often results in overexploitation of natural environments and rural areas. This pattern is particularly marked in tropical and Mediterranean areas, which are sensitive to climate change and subject to strong environmental constraints (deforestation, desertification, erosion, etc).

The continued functioning of rural areas, particularly those involved in production, is in some jeopardy. Human societies' exploitation of the natural environment and of manmade environments interacts significantly with ecological dynamics. These relations raise questions on how to manage risks and changes in farming practices as well as the surrounding environment. This comes back again to governance of rural areas and relevant public policies. Territorial management is a major issue, along with environmental questions and the recognition of environmental public goods.

Six strategic lines of research

Ecological intensification

Biomass energy

Food

Animal health and emerging diseases

Public policies

Rural areas

Concentrating
CIRAD's research on a limited number of scientific priorities

CIRAD has identified six strategic lines of research so as to structure its operations.

Global agriculture as it is currently practised will probably be unable to tackle the following three major challenges: feeding the world, ensuring energy production and preserving the environment, simultaneously. Yields have peaked and a very large share of the world's cultivable land is already farmed[11]. Furthermore, massive use of biofuels could result in increased deforestation and in food shortages in zones with low agricultural yields, and even in some intensively farmed zones. Agricultural research has the task of reducing this global tension, but this is a huge undertaking and the research forces that have been mobilized worldwide so far remain limited.

Agricultural research needs to satisfy both present and future needs and to tackle all three apparently contradictory concerns. CIRAD has neither the size nor the capacity required to address all the questions posed, but its history and its unique position entitle it to be ambitious. In the aim of concentrating its resources on critical issues, and using its recognized experience and expertise, CIRAD has identified six strategic lines of research, so as to structure its operations.

CIRAD is addressing these challenges without creating new structures or establishing special assessment procedures. These lines of research provide an opportunity to mobilize its staff and to communicate, both inside and outside CIRAD. Some lines of research will define ongoing and potential activities for many research teams, while others will concern fewer teams.

The three key issues —human and social, environment and energy, and public policy and governance— are interrelated and will affect all or most developing countries. They are complementary and mutually interactive. This is clearly illustrated in Line 5 (public policies), for which re-examining public roles and regulatory capacities is necessary to provide the conditions for relevant research on topics such as ecological intensification, health, bioenergy, environment and food. Similarly, in speaking of food safety (Line 3), one must consider the interactions between agriculture and the environment.

[11] Michel Griffon : *"Une compétition entre cultures alimentaires et énergétique"*, Le Monde, 3 April 2007.

Line 1 Ecological intensification

Helping to invent ecologically intensive agriculture to feed the world

Increasing agricultural production is still a major priority, but agricultural strategies based on massive use of pesticides, chemical fertilizers, water and fossil fuels are now seriously called into question. It is time to break with the conventional agricultural model in which systems are increasingly artificial and uniform, and also severely strain ecosystems. Agricultural systems should be designed to use ecological processes and functions for many purposes. These include controlling biological pests, reducing weeds and invasive species, making more efficient use of scarce resources (such as water), and enhancing ecological services (carbon storage, biodiversity, prevention of so-called natural catastrophes). This is the premise of ecological intensification. It involves managing living systems, recognizing and supporting their complexity and diversity, and using the broad range of interactions that regulate those systems.

To create ecologically intensive agriculture, old research issues will have to be reframed and new ones formulated. CIRAD will help developing countries take this important step towards sustainable agricultural change by focusing research on four complementary and interrelated research topics:

- plant breeding, which is fundamental for agriculture, particularly when studied together with biological functioning and ongoing changes in production systems;
- designing ecologically intensive production systems that contribute to the biological, technical and organizational aspects of sustainable development;
- *ex-ante* and *ex-post* assessment of production systems in relation to the production of environmental services and the sustainability and viability of socioeconomic changes;
- innovation as a participatory process with many stakeholders.

Five key topics emerge from this preliminary analysis.

Diversified, adaptable plant breeding. Plants with a long growth cycle will be monitored within the framework of sustainable partnerships that nurture South-South collaboration. Access to the genetic diversity of the main edible plant species will be provided through collaborations with the Consultative Group on International Agricultural Research (CGIAR) and by setting up small representative plant collections to subsequently serve as internationally recognized germplasm repositories. The main crops will be studied with respect to their interactions with crop pests.

Adaptation to environmental constraints —especially water supply shortages and climate change—will be analysed for a few plants such as rice, sorghum and eucalyptus, with the aim of benefiting from behavioural similarities with other major crops. Varieties will be selected through improved selection procedures and field testing arrangements, involving all the stakeholders in the target production systems.

Breaking with the traditional paradigm of agriculture that increasingly artificializes, uniformizes and standardizes, and that puts biological systems under pressure

Line 1 Ecological intensification

Integrative production system design. To develop sustainable production systems, many factors must be taken into account or studied:
- local and empirical know-how that helps to develop new expertise;
- in-depth knowledge of interactions between biotic and abiotic factors;
- more efficient use of functional biodiversity.

Using biodiversity in this way means studying the association of plants and animals in space and over time, as well as using biological processes, through both the competition between them and their complementarity. Product quality and market expectations must be taken into account in production systems. Finally, co-product processing and development systems are required to enhance the added value of commodities.

Taking account of product quality and market expectations in production systems

Functional agroecology. Biological processes will be studied in representative regions. Soil fertility, a key concern, will be studied by looking at the interactions between plants and microorganisms so as to describe, explain and use biodiversity and key symbioses to help restore soil fertility. Demographic and adaptive processes among biological pest populations will be studied to gain insight into tolerance durability and to predict the risks of epidemic disease outbreaks and resurgence. The methods and understanding thus developed will contribute to the knowledge base for developing climate change adaptation strategies.

Describing, explaining and exploiting the biodiversity of and the functions that regulate ecosystems

Modelling, decision support, assessment. Production system modelling will take account of the impacts of ecologically intensive practices. These include allelopathic effects, the effects of physical protection to counter the spread of diseases, and better environmental resource sharing. Modelling both performance patterns and technical choices will help develop decision-making tools. Based on flow studies and knowledge (bio-geochemical cycles, water cycles, etc), multi-criteria evaluation methods will be developed to assess the implementation of ecologically intensive technologies and the long-term impacts of these technologies on biological, social, economic and territorial changes. These will include ecosystem evolution and environmental services (biodiversity, improvements to runoff or leached water quality, pollutant flows, etc).

Proposing multi-criteria methods to assess the use of ecological intensive technologies

Innovation. Ecologically intensive agriculture requires background knowledge, technical expertise, and the capacity to innovate. Special emphasis will therefore be placed on stakeholders' learning capacity, which is necessary for them to independently assess new ecological and individual and collective organization issues as they arise. Analyses will focus on ways of organizing production and on public and private policies that promote (or hamper) innovation for ecological intensification. These analyses are intended to strengthen the flexibility and adaptation capacities of production systems and support innovation.

Building stakeholders' learning capacity, to allow them to independently assess new ecological and individual and collective organization issues

Line 2 Biomass energy

Analysing the conditions for the development of bioenergies and ensuring that they benefit people in developing countries

In developing countries, the use of biomass for fuel fulfils different objectives depending on the needs of the countries and their inhabitants. Uses range from supplying fuelwood for cooking to agrofuel and industrial fuel production. CIRAD will focus research on sustainable production systems in rural communities.

For such communities, agrofuel production generates new development opportunities, but also risks. These include social risks (associated with land use and management, market commodity chain restructuring, upsetting conventional uses, impacts on food production, etc), environmental risks (associated with the energy efficiency of systems), and economic risks (associated with the impact on farmers' income, income distribution within new production chains, competition between food and fuel uses, jeopardizing food crops, etc). In this new setting, CIRAD intends to address a few concerns, some of which raise very new research issues.

Assessing the efficiency and sustainability of biomass production

Biomass production. Biomass production will be studied for sustainable production systems in rural communities. The efficiency and sustainability of biomass production will be assessed from two different standpoints:

- adapting and streamlining current production systems for fuel (eg woody forest trees), or for combined end uses (eg sugarcane) while quantifying regional potentials;
- conducting a comparative study of production systems devoted *de novo* to biofuels (eg *Jatropha*).

Genetic and physiological analyses of plant material will be carried out through current plant breeding projects before establishing biofuel production as a breeding objective. The focus will be on:

- certain tropical trees (eucalyptus) for fuel production via pyrolysis, while targeting research on genes involved in the lignin biosynthesis chain;
- oil palm for studying agrofuel (including biodiesel) production conditions and concentrating on hybrids;
- plants that use C4 metabolism (sugarcane, sorghum), to tap their potential for producing various types of biomass (seeds, fibres, sugars).

Building tools and organizational methods to enable integrated management of these production chains

Impacts of biomass production. Innovations concerning these production systems will be covered within the framework of land use planning strategies, while taking conventional systems into account. Studies on upsizing from plot to territory will systematically be conducted in order to assess the environmental impacts and ecological services of these innovations on a landscape scale using energy yield simulation models. By combining socioeconomic and technical approaches, tools will be constructed and organizational conditions determined for the integrated management of these production chains. Finally, to prepare for and enhance public policies, work will continue to determine how biofuel development affects food production and markets, alters common resource management conditions (land and water use management conflicts) and influences socioeconomic development, even beyond the agricultural sector.

Biomass processing. This involves designing and tailoring efficient, ecofriendly means of transforming biomass into fuel through thermochemical and fermentation processes. At the same time, technical energy-saving solutions need to be found for rural communities and implemented throughout the chain of agricultural practices, postharvest processes and integrated systems. In addition, priority will be given to studies on the economic, social and environmental impacts of methods for generating fuel from crop residue, byproducts and processing waste.

3 Line Food

Innovating, to make food accessible, varied and safe

Food security can be considered both quantitatively and qualitatively. Qualitative food security refers to the nutritional value, diversity, origin and environmental impact of foods, as well as to consumers' tastes and health. These quality factors have become public health issues for rural and urban populations in nutritional transition.

As an increasing number of food products are passing through markets, issues of competitiveness, production chain organization and exclusion may arise, along with changes in the agrifoods sector (collection, processing, distribution).

Research should be focused on analysing these changes and gaining insight into the key factors, while facilitating the development and assessment of technical specifications and agrifood policies adapted to this new setting.
CIRAD will focus on staple food products (cereals, starchy substances, tubers) and on horticulture in general.

Production systems and food crops. Priority will be given to horticulture in its broadest sense, under periurban conditions. The aim is to design production systems based on ecofriendly and quality-oriented methods that are in turn based on the analysis and understanding of "genotype x environment x crop management x processing" interactions. The genetic potential of cultivated varieties and species needs attention, especially the effects on food composition and structure. At the same time, we need to reduce variability and facilitate preservation and transformation processes. Breeding objectives will also include criteria emerging from consumer surveys.

Understanding the relations between genotype, environment, crop management and processing

Contaminants, and nutritional, health and organoleptic quality. Quality markers —nutritional, health and organoleptic— will be identified for food products obtained in different production systems. These markers will subsequently be used to determine the conditions required to achieve optimum quality, from raw material to end product. Specific measurement methods will also be developed to evaluate these markers. The aim is to minimize the risks associated with the presence of toxic contaminants (eg by developing systems requiring very little pesticide input or using organic farming systems), or linked with the presence of toxinogenic contaminants (eg by developing crop management sequences that would hamper mycotoxin development). Specific tools will be required to develop low-risk production systems, including for instance:
- analysis of pollution channels based on quantifying toxic substance flows in the soil-plant-atmosphere continuum throughout the chain;
- knowledge of the metabolization of active substances.

Determining the conditions required to achieve optimum quality

Line 3 Food

The resulting studies should enable the development of multi-criteria methods for the assessment of agricultural production procedures tailored to food production chains, for example by taking health issues specific to periurban agricultural production into account. Models and decision support tools will be developed through an integrated systems approach. These models and tools will be designed for use in determining quality, food safety and traceability and also to assess and forecast risks in agrifood production chains: fungal toxins, microbial contamination, chem-ical pollutants, etc.

Designing processes that combine traditional know-how with technological expertise

Processing methods. The aim is to design processes that combine traditional know-how with technological expertise in order to make better use of the quality features of products. This can include strategies for differentiating products. The impacts of these differentiation strategies also need to be considered on social equity grounds, on a case-by-case basis. Studies of traditional know-how will be carried out, and technological innovations will be developed and validated based on consumer surveys. For fresh produce, the focus will be on postharvest technologies that curb quality degradation. For staple foods, developing better processing methods (fractionation, separation, preparation and assembly of stable foods), tailored to local production conditions, will be key.

Helping producers in the South adapt to socioeconomic changes

Building the adaptation capacities of producers in the South. The boom in the retailing and distribution industry and the advent of agrifood macro-stakeholders has markedly changed the balance of power between producers and distributors in developing countries. These changes also threaten to widen the North-South divide and to push small-scale producers out of the market. A strongly-supported argument based on three interacting dynamics is required to strengthen the ability of small-scale producers to influence market functioning and anticipate its effects. Those dynamics are:

- changes in the expectations and behaviour of consumers (who are, to an increasing extent, urban);
- drawing up new international agrifood regulations to frame government and company activities;
- increased use of health, social and environmental standards.

CIRAD will be taking these dynamics on board so as to help producers in the South adapt to socioeconomic changes on local and regional scales, and on an international scale for some products.

Line 4

Animal health and emerging diseases

Foreseeing and managing infectious disease risks linked to wildlife and domestic animals

Animal health risks can have a dual negative impact: they can drain rural producers' economic resources and have serious impacts on human health.
The prevalence of emerging and reemerging animal diseases is steadily rising, including zoonotic diseases that seriously threaten human populations in the South and North.

The increase in international trade; climate change and ecological crises; urbanization; the decline of public health systems in developing countries; and livestock production intensification have combined to provide a setting favourable to the survival, spread and emergence of animal and zoonotic diseases. These developments have major potential economic and health impacts.
CIRAD, whose expertise in this domain is recognized worldwide, needs to integrate and strengthen its research—ranging from genomics to ecology and from epidemiology to social sciences—further, through global initiatives and partnerships.

Focusing research on major endemic diseases, with particular emphasis on zoonotic and vector-borne diseases

Understanding disease emergence and spread. CIRAD will focus research on major endemic diseases that are still poorly managed in the South, especially zoonotic diseases (Rift Valley fever, avian influenza, etc) and vector-borne diseases. These are becoming an increasing threat in the light of current global change, particularly global warming. Disease emergence, transmission and diffusion mechanisms will be studied, especially via interdisciplinary approaches. These approaches combine:

- assessment of the diversity and plasticity of the genomes of pathogens, potential vectors and hosts, as well as identification of specific markers for the analysis and characterization of target genes, with the aim of developing new vaccine strategies;
- research on immunopathology for functional determination of genetic variability in protective immune responses;
- genetic-genomic and biological-ecological aspects of interactions between hosts, vectors and pathogens for a few model diseases (ovine bluetongue, heartwater, African swine fever, human and animal African trypanosomiasis);
- population studies to define and quantify disease risk and emergence factors, combining quantitative epidemiology, ecology and geographical health research.

Disease risk modelling and management. Integrative approaches are being developed that incorporate key biological, ecological, economic and sociological factors of animal disease emergence and resurgence (particularly for zoonotic diseases). Dynamic models that simulate the onset and spread of these diseases will be developed to assess the relevance of acquired knowledge, pinpoint current flaws and test disease prevention and control strategies. Disease surveillance and control strategies developed by health stakeholders (and their ecological, economic and social impacts) will also be the focus of research in various settings. The results of this research should help to adapt political and regulatory frameworks and to develop new tools, especially for early disease warning.

Studying the surveillance and control strategies developed by health stakeholders, and their ecological, economic and social impacts

Line 5 Public policies

Supporting public policies aimed at reducing structural inequality and poverty

Structural inequalities associated with “underdevelopment” have concerned the international community ever since the World Summit on Sustainable Development in Johannesburg in 2002 and since the UN Millennium Development Goals were set out. It is clear that both policy regulation and mobilization of civil society will be required to reduce these structural inequalities.

Public policy, like any other change factor, must be a priority focus of research and support. This means that public, local, national and international action should be reconsidered and its scope broadened to cover several new issues that are commonly handled by agricultural research.

Characterizing the factors associated with increasing inequality and poverty in rural areas

Knowledge of the adaptation capacities of vulnerable stakeholders. CIRAD aims to identify vulnerable stakeholders and assess the adaptation capacities of poor or declining communities. Comparative studies will be carried out under different “South” settings (emerging countries, least advanced countries, failing states, and French overseas regions) so as to gain greater insight into links between political situations and increasing poverty. This will mean analysing the social, economic and political processes functioning on various scales and concerning producers and consumers, production chains and distribution networks, and characterizing the factors associated with increasing inequality and poverty in rural areas.

Multi-criteria policy assessment. Multi-criteria methods will be developed to assess the impact of sectorial and territorial policies and of international regulatory tools on rural living conditions and production. *Ex-ante*, *ex-post* and ongoing assessments will focus on policies specifically designed to reduce inequalities. Assessments will be carried out to determine the role of access to production factors (including appropriation of genetic resources and chemical inputs) and of production and processing techniques. These assessments will be based on local, national and international observation and analyses. They will allow interpretation of interactions between agricultural production and policy processes that are designed and implemented on different scales. The results of these assessments will be useful for setting up monitoring systems for agricultural situations worldwide. Special attention will be placed on assessing the impacts of trade liberalization, direct competition between agricultural strategies, and the withdrawal of government backing for training and support services and infrastructures.

Assessing the impact of sectorial and territorial policies and of international regulatory tools

Remodelling public action. Research will involve the analysis and follow-up of sectorial and territorial public policy-making in the agricultural sector, as well as food, land, environment and resource management. The knowledge collected will facilitate the development of new regulatory frameworks that better meet the UN Millennium Development Goals. Discussions will consider the state of scientific knowledge resulting from the combination of agronomic and socioeconomic models and its role in drawing up these regulatory frameworks.

Role of agriculture in reducing structural inequalities and poverty. Research will continue to determine the contribution of the agricultural sector to reducing structural inequalities and poverty in rural and urban areas from the following standpoints: jobs and incomes, living conditions, food and health, and migration phenomena. This research will provide food for thought and planning on redesigning development models, while orienting the debates on agricultural multifunctionality and the role of family farming.

Line 6 Rural areas

Understanding relationships between agriculture and the environment and between human communities and nature better, so as to manage rural areas sustainably

The functioning of agroecosystems in rural areas
and in ecosystems less affected by human activities
(forests, pastoral areas, protected areas, etc)
is in jeopardy in many regions throughout the world.
This is seen in the impact of agricultural production
on ecosystem dynamics and vice versa.
Furthermore, the extension of agriculture creates strong
pressure—and sometimes conflict—as regards environmental
issues and recognition of environmental public goods.
The challenge is to develop a land use engineering strategy
based on both agricultural production and restoration
of the ecological services rendered by ecosystems.

Developing multi-criteria methods to assess relationships between the environmentand agriculture-animal production on different scales

Agriculture and environment. Research will focus on the analysis and quantification of the impacts and environmental services generated by agriculture and animal production, particularly as regards soil fertility, biodiversity, carbon sequestration and water quality. New multi-criteria methods will have to be developed to assess relationships between the environment and agriculture-animal production on different scales, especially on a landscape scale.

Organizational or institutional entities that may provide public mechanisms to promote these services will also be studied, especially when it is necessary to combine biophysical functioning models with decision-making models. These initiatives must increasingly be results-based, as means-based methods are increasingly being superseded by the need to show results. New indicators and standards will be required for this transition.

Relationships between human communities and nature in its broadest sense. Management of territorial dynamics and associated risks will be priority research topics for CIRAD. Management and governance processes are increasingly characterized by a broad range of stakeholders who may have contradictory goals which are not always fully coordinated. Thus research will focus on gaining insight into interactions between agro-ecological dynamics, stakeholders' behaviour, and public and collective decisions. Governance structures set up to ensure sustainable development will be examined.

Interactions between human societies and nature in its broadest sense will be studied using approaches that combine the life sciences, humanities and social sciences. Research carried out in areas relatively unaffected by human activities will be developed and broadened to include other similar situations. This will involve comparative studies, including a human impact gradient.

Farming areas versus protected areas. Studies on interactions between agriculture and ecosystems will include an analysis of interfaces between arable areas, ecosystems with manageable resources, and areas to be protected because of their environmental significance. CIRAD will investigate three key issues associated with setting up new protected area structures:

- development of standards to guide actions concerning public goods and ways in which these standards can facilitate upgrading of local or global action frameworks;
- the ecological and social impact of these structures, especially on the periphery;
- land management: land use patterns in rural areas, impact of environmental concerns in these rural farming areas, and links between rural and protected areas with respect to conservation arrangements.

Analysing the interfaces between arable areas, ecosystems with manageable resources, and areas to be protected

CIRAD in a nutshell

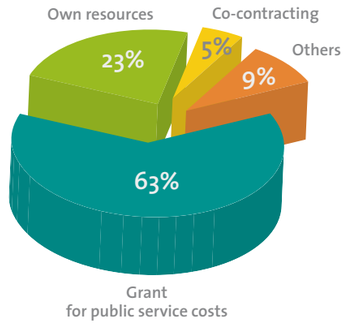
CIRAD is a French public establishment, placed under the joint authority of the Ministry of Higher Education and Research and the Ministry of Foreign and European Affairs. It is a research centre specializing in tropical and Mediterranean agriculture.

CIRAD's operations encompass the life and earth sciences, social sciences and engineering sciences, applied to agriculture, forestry, animal production, food, natural resources and rural territories.

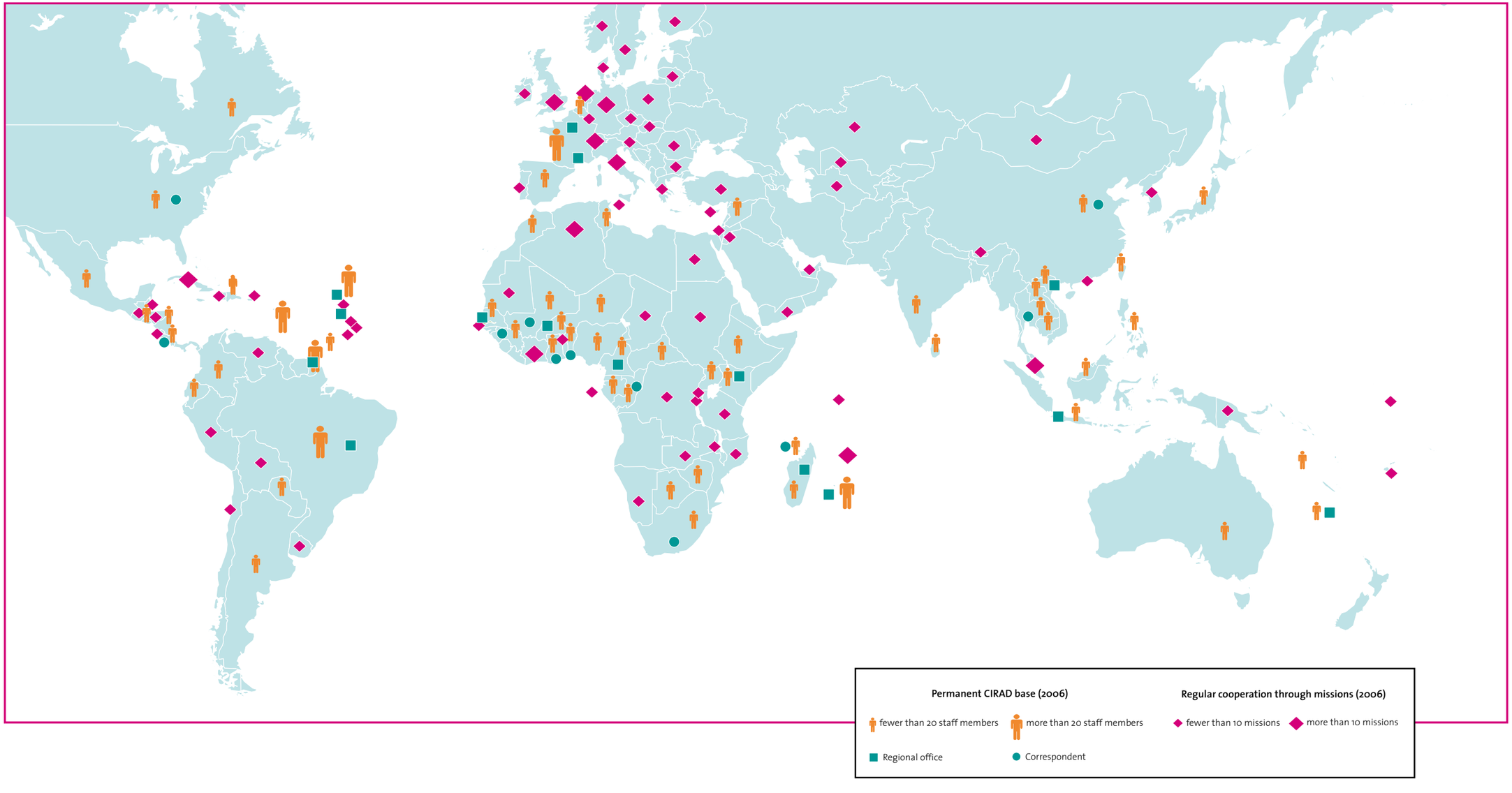
CIRAD has 59 research units split between three scientific departments: Biological Systems (BIOS), Performance of Tropical Production and Processing Systems (PERSYST), and Environments and Societies (ES).

CIRAD has a staff of 1800, including 800 researchers. It works with more than 90 countries, and has regional scientific platforms in the French overseas regions.

It has a budget of 203 million euros, with two thirds provided by the French government.



CIRAD worldwide



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